Dental fillings without gaps

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The researchers initially investigate how the material reacts to stresses, using a plastic filling in a standard geometry. Credit: Fraunhofer IWM

Tooth cavities are usually closed with plastic fillings. However, the initially soft plastic shrinks as it hardens. The tension can cause gaps to appear between the tooth and the filling, encouraging more caries to form. For the first time, researchers have simulated this process.

The patient's hands are clasped firmly around the armrests as the dentist drills away the caries-stricken sections of the tooth. Once the drilling is over, most toothache sufferers can begin to relax. All the doctor now has to do is to slightly etch the cavity, apply an adhesive film, and fill it with a special type of plastic.

The plastic is soft at first, so that the doctor can easily press it into the cavity. It only solidifies afterwards under the light of a small lamp.

However, the material tends to shrink slightly as it hardens, occasionally producing tension that can cause tiny gaps to form between the plastic filling and the tooth. Bits of food can get caught in these gaps and lead to more caries. Manufacturers of filling materials therefore offer a variety of plastics to choose from. But which filling is best suited to which shape of cavity? This is where dentists have to draw on their experience.

"Until now, it has not been possible to establish a theoretical model of the hardening process. The tension occurring in the material always depends on the shape of the cavity, and can vary widely by a factor of up to ten, particularly at the edges," says Dr.-Ing. Christof Koplin, research assistant at the Fraunhofer Institute for Mechanics of Materials IWM in Freiburg. Measurements do not help either, as tension can only be measured selectively. Its precise course of development has never yet been observed.

A new method of simulation now enables tension in dental fillings to be accurately predicted, helping doctors to choose the least tension-prone plastic for each shape of cavity. Dentists can now draw on the results of the IWM to select the best material, and manufacturers can use the simulations to optimize their products.

"We theoretically subdivide the dental filling into thousands of small parcels and calculate how each element affects its neighbor. Experimental parameters are incorporated in the individual elements. We started our laboratory tests by using a standard geometry to find out how each material reacts to the stresses that occur when the volume shrinks, and how the flow capability of the material changes as it hardens," explains Koplin. The IWM researchers have now successfully simulated the development of tension in dental fillings for various cavity shapes and materials, and more will follow.

Source: Fraunhofer-Gesellschaft